the probability of the observed associations between the dependent variable and the set of independent variables occurring by chance is extremely small.

Residual Analysis

While the multiple regression equations described above accounted for as much as 60 percent of the variation in county-level utilization, this still leaves at least 40 percent unexplained. Thus one might ask for which counties is the prediction of utilization good and for which counties is it poor. A procedure that helps answer this question is the mapping of regression residuals. A residual is basically the difference between the actual value and the predicted value generated by the regression equation. In this analysis, the residuals identify the counties that have utilization rates that are not being predicted very well by the multiple regression equation. This could lead to the selection of areas for intensive investigation and to the formation of additional variables to use in explaining utilization.

The regression residual maps are shown in Figures 5 through 8. One county that stands out in three of the maps is Gates County. The residual for this county is more than two standard errors above the predicted value, which indicates that the residents are utilizing hospitals much more than would be predicted based on its values on the independent variables. A possible reason for this discrepancy is that some counties along the border had their discharge rates adjusted for an estimated percentage going out of state for hospital care. If this adjustment were too high for Gates County, then that county's discharge rate would be artifically inflated. Another possible reason for Gates County having a high residual is that the county's population is very small. Small populations produce a small number of discharges in the numerator, and artifically high or low rates may occur in a random fashion. However, if a county has a large population and little migration out of North Carolina for hospital care, more confidence can be placed in the measured utilization rates, and thus the residuals will be better indicators of unusual county utilization.

Another technique that may suggest additional predictor variables to include is spatial autocorrelation. This procedure tests whether values in one geographic place are dependent on values in another geographic place. Positive spatial autocorrelation exists when the values in adjacent places are similar. This signifies a geographic clustering of similar values. There is no autocorrelation when the values of the places are randomly distributed.

In this analysis, residuals from the regression equation were entered into the spatial autocorrelation test. Spatial autocorrelation of the residuals would suggest the existence of spatial or regional explanations for the pattern of deviations from the predicted values. The residuals were first divided into positive and negative values, and the number of adjacencies between the positive residual counties and the negative residual counties were tested against a random distribution. Chi-square statistics were then calculated to evaluate whether or not the frequencies that were empirically obtained differed significantly from the expected values. For all four maps the chi-square statistic was not significant. Consequently, the residuals from the regression equation do not appear to be spatially autocorrelated.

Summary and Discussion

Several statistical analyses were used to assess the relative impact of various factors on general hospital utilization. The results showed that sixty-seven percent of the variation in total hospital utilization was explained by ten health resource and residence-based variables. Maps of counties with utilization rates substantially higher or lower than the rate predicted from the regression equation are presented in order to identify areas with unusual patterns and suggest reasons for these variations. For all but one age category, the bed-to-population ratio explained the largest proportion of variation in hospital utilization: in general, the higher this ratio in a county, the higher the utilization of its residents. Other important variables were average length of stay (negative relationship), the percentage of the population that were Medicare disabled enrollees (positive), and the physician-to-population ratio (negative).

The strong relationship between the bed-to-population ratio and inpatient hospital utilization has been documented in other studies (1,6,22). Even after holding constant the effects of other variables upon utilization, high bed supply has a positive impact. One explanation could be that empty hospital beds influence physicians' decisions to admit patients into the hospital. This would be a case of the supply of medical resources in an area influencing demand. Davis and Russell (7) found that the demand for outpatient care is sensitive to the inpatient occupancy rate. They suggest that when hospital inpatient facilities are crowded, physicians switch more patients into outpatient care; therefore, a policy aimed at restricting the supply of beds and keeping occupancy rates high may cause a reallocation of resources to less